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THE COMPOSITE ORIGIN OF TOPOGRAPHIC FORMS.

BY

ALBERT PERRY BRIGHAM.

The genetic method cannot be neglected by the modern geographer. Topographic form is sure to raise the question of origin. The analysis and classification of such forms can scarcely proceed on any other basis, as even casual reference to the literature of the subject will show.* With the untrained, but interested observer, as well as with the scholarly student of nature, the first question is,—how? Every form is dependent on material and structure and is the resultant of a group of forces acting conjointly or in close succession, and in varying proportion of efficiency. Every teacher finds increasing difficulty in referring forms truthfully to the agents that moulded them. He is aware that he supplies the beginner with a crude classification which will be modified as the student becomes able to grasp the complex history of the form under consideration. Wider observation will always supply a graded series incapable of hard and fast grouping. The genetic series is comparable to those of the organic kingdom, and Darwin's remark on the increasing difficulties of the young naturalist as he surveys increasing numbers of related specimens is equally pertinent here. The interdependence also, of biologic, groups, in the struggle for existence, finds a close parallel in the geographic field.

There is, at the present time, increasing recognition of certain form-making agents which have not heretofore received due attention. Eolic geology is one of these little tilled fields. Le Conte's larger work dismisses the subject with less than a page. The formation of dunes and the effectiveness of the natural sand-blast, in certain situations, comprise nearly the whole body of published fact until quite recently. Yet the total of wind action in transporting material and in completing the sum of topographic expression cannot be otherwise than very great. At the late Baltimore meeting of the Geological Society of America Mr. G. K. Gilbert presented a paper on the Formation of Lake-basins by Wind, in the arid regions of the West. Mr. J. B. Woodworth has recently published a useful discussion of wind work in New England,* and Mr. J. A. Udden has set forth the laws of the erosive and transporting work of the atmosphere.† The co-operation of the atmosphere with water in the constructive and destructive movements of waves, also, has been taken for granted rather than recognized at its true value. It is not too much to say that the structure and surface of all terranes, ancient and modern, have been affected by eolian action.

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* See as examples, The Classification of Lake Basins, W. M. Davis, Proc. Boston Soc. Nat. Hist., Vol. XXI, 1882; also, Proposed Genetic Classification of Pleistocene Glacial Formations, T. C. Chamberlin, Jour. Geol., Vol. II, pp. 517–538, July–Aug., 1894.

Anthropic geology has not fared much better, though Professor Marsh's Man and Nature marks a somewhat early attempt in the right direction. It seems safe to say that, by deforesting and by tillage, man has doubled the rate of surface degradation over large tracts of country. By his means, gravity, the winds, atmospheric erosion and the mechanical work of rain and streams have been multiplied in effectiveness, as is witnessed by streams which run full loaded after each shower, whereas before man's occupancy of the field their crystal clearness was rarely dimmed. That man is the central theme in geographic study would scarcely fail of recognition by any, but that he is an actual maker of topography probably occurs to few who are not students of earth forms. Even such would fail of the truth, if they are accustomed to view such forms as dead, or as apart from a constant and most complex historical development.

The principle of composite agency applies to continental evolution in general. The building and uplifting processes unite with the down-wearing processes. Constructive work is accompanied by degradational activity in ever shifting proportion. Thus the making and distribution of sediments involves the nature and extent of previous land surfaces, the plan of their drainage systems, the character of the sea floor, the direction and power of winds, currents and tides. The nature of the sediments, rapidity of accumulation and other conditions, regulate consolidation. The rate and character of the force which turns this sea bottom into a land surface is then to be considered, and vulcanism may enter at any time to vary the assemblage of material and add new elements of structure to the mass. We will suppose the above network of agencies to have been operative, with a resulting land surface of average continental relief. The forces which must already have begun the process of base-levelling will be followed up in certain directions in illustration of our theme. The history of a cycle of base-levelling is the joint product of structure and erosion. But as structure is a composite affair, so general erosion is accomplished by many agencies, and is accompanied by many episodical constructional processes and forms.

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* Post-glacial Eolian Action in Southern New England, Am. Jour. Sci., Vol. XLVII, pp. 63–71, Jan., 1894.

† Erosion, Transportation and Sedimentation Performed by the Atmosphere, Jour. Geol., Vol. II, pp. 318–331, Apr.–May, 1894.

The distinction between hard and soft, or better, between rocks more and less destructible by erosive agencies, finds illustration in all topography. Thus Geikie says:* "This relation between relative destructibility and external configuration is traceable in every part of Scotland, and indeed may be regarded as the law that has mainly determined the present topography of the country." The author describes the marked contrast between areas of ancient sandstones forming terraced cones or pyramids, and the yet more ancient gneisses, wrought into a "tumbled sea," by a compound of weathering, sea action and glacial grinding. The topographic resultants of variant horizontal beds may perhaps be best studied in Western America. Dutton's Tertiary History of the Grand Cañon District is little else than an amplification of this theme, and to this may be added every illustration of Bad-Land topography in our official surveys of the West. Hardly less instructive are our more modest, and often glacially modified or obscured "escarpments," in regions of horizontal sediments in the East. Gilbert has shown how the rapid erosion of the upper member of a topographic series, will modify the conditions for all lower members, in a given drainage basin: "As any member of the system may influence all the others, so each member is influenced by every other."† This well emphasizes the difficulty of adequately stating all the conditions of even the simplest topographic problem. The variant characters of igneous rocks and their relations to inclosing, or subjacent sediments, show beautifully the topographic importance of rock characters. Thus we may compare the rhyolitic tables and mesa caps of Colorado with the rugged needle-shaped peaks of the San Juan, hewn from vast sheets of andesitic lava, or we may put over against these the characteristic granitic domes of the Platte Valley in the same State. Geikie notes this weathering of granite in his account of the Highland Hills,‡ where he describes it as "a rock which, from its usual decomposing character, and its abundant vertical joints, combines in its decay a grandeur of lofty cliff with a smoothness of mountain top such as none of the other Highland rocks can boast." Becker illustrates the same law in the Sierras of California.* The same writer† notes the topographic effects of horizontal lava capping. If lava sheets be poured out upon a surface, or intercolated between beds of sediment, and the whole mass moderately tilted, we have the conditions presented by the trap sheets of Connecticut and New Jersey. We may compare the structure of Salisbury Crag and Arthur's Seat in Scotland,‡ the former being due to an intrusive sheet, while the latter is a solitary mass or boss. In such cases the topographic result would vary with the relative hardness of the lava and the sediments, the relative thickness of the two, the number of alternations between them, the amount of tilting and the subsequent lapse of time.

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* Scenery of Scotland, p. 108.

† Geology of the Henry Mountains, pp. 123–124.

‡ Scenery of Scotland, p. 199.

The same considerations apply if the entire column is sedimentary. As already noted, the variety of result may be very great, if the beds weather and are dissected in their original, approximately horizontal attitude. If we break them into crust blocks and tilt them, we get a type of mountain and valley illustrated in the Great Basin. If we fold the series we introduce infinite possibilities in topographic history. Some of the factors are: (1) Direction of application of the force, determining the chief lines of mountain and valley, as in the main trends of Scotland and the Appalachians; (2) Ratio of force to resistance of beds, in virtue of their hardness or thickness, thus determining the folds as open or close, reversed or faulted; (3) Rate of application of the force as compared with the sum of erosive energy, determining whether the antecedent drainage system shall survive the change of conditions; (4) Presence or absence of hard beds of good thickness to act as topographic determinants of the main ridges and included valleys.

In such a region of anticlinal and synclinal axes, topographic development and interest centre in the drainage history, as controlled by the above-named dynamic and structural factors. Henceforth amount of seaward slope, climate, and character of beds in detail determine the river history; and the cutting down and broadening of valleys, the reduction of summits and slopes, headwater capture and lateral migration, with transport and incidental new constructional forms of the "waste of the land," are steps in the progress toward ultimate base-level.

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* The structure of a portion of the Sierra Nevada of California, by G. F. Becker, Bull. Geol. Soc. of America, Vol. 2, p. 69.

† Op. Cit., p. 66.

‡ Scenery of Scotland, pp. 333 and 356, and folding geological map with sections at close of volume.

Powerful as structural factors are, it is important to recognize the limits of their efficiency. By submergence, sedimentation and recovery, a new drainage system may be superimposed upon an old one, with disregard of the old structural and erosion features, at least until the work is again far advanced. In warm and moist climates topography is probably less dependent upon structure. Greater altitude with its attendant conditions may overrule structure, as in the striking case described by Gilbert in the Henry Mountains,* where Mount Ellen, altitude 11,250 feet, has a smooth crest and even slopes, and Mount Holmes, altitude 7,775 feet, is ribbed with ragged dikes, etched into high relief. The difference is due to the moisture and vegetation of the higher altitudes.

As has been elaborated by Davis and others, a normal cycle of geographic development may be interrupted by oscillatory movements of a decided character. If the movement be downward, erosive work is retarded and the area will exhibit a system of fiords about its seaward margin; or, if base-level had been approximated, it is conceivable that the resulting peneplain might be carried beneath the sea, or so nearly that the waves would complete the work by forming a plain of marine denudation. If the movement were an upward one, the base-levelling forces would increase in energy as a greater task was given them, and if a peneplain had been formed, it would become an elevated plateau subject to vigorous erosive dissection. From this dissection a secondary base-level of part of the region concerned, would in time result. This might go on until the entire plateau were destroyed, or another uplift might ensue, carrying up the second base-level some hundreds of feet above the sea, and at the same time lifting the remnants of the original peneplain correspondingly higher. This is the actual history of the Southern Appalachians since Cretaceous time.† Such a history would probably be always complicated by many minor oscillations, and by varying degrees of oscillation, producing deformation in parts of a given area. To sum up these remarks on the base-levelling process in general, we may say that the finest illustration of our thesis is the rare completion of base-level, or the critical balance between uplift and denudation, each checking the other, marked upheaval occasioning rapid degradation, resulting always in a limit of altitude and medium of climate, favorable to organic life.

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* Geology of the Henry Mountains, pp. 117–120.

† See Geomorphology of the Southern Appalachians, by Willard Hayes and Marius R. Campbell, Nat. Geog. Mag., Vol. VI, pp. 63–126.

I propose now to review certain special classes of topographic forms from the point of view of their composite origin. These forms have already been called episodical, as related to the general history of the land.

Probably no better illustration of our principle exists, than the fresh-water deposits of the ice time. Here would be noted especially the topographic individuals known in current terminology as kames, eskers, frontal aprons, fossil deltas or sand plains, valley trains, and beaches and bottoms of glacial lakes. These are water deposits, but due to water complicated with effects of ice mass and movement, and pre-existing topography. The study of earth forms has few passages of greater interest than the early attempts of geologists to deal with kames. Kames is a Scotch term applied to assemblages of short, conical, often steep hills, built of stratified materials and interlocking and blending in the most diversified manner. They offer a group of features which can but strike attention, but whose mode of origin has as yet no place in the common teaching of Physical Geography. They rarely fail of being opened, for the hauling of sand and gravel, or for purposes of interment, and are always and truthfully ascribed to water action, but they are imperfectly seen, the imagination is not exercised, the reason is left unsatisfied, and their educational value is lost, because their composite history is rarely known, and therefore is not taught, save in the higher grades of instruction. One of the earliest allusions to these hills as forming a district class, is found in the Geology of New York.* Of greater interest, as grappling with the problem of origin, is a passage in Hitchcock's Report on the Geology of Massachusetts.† "That they were the result of running water, no one who has seen them can doubt . . . . But they occur on a scale so immensely larger than anything now witnessed, that the mind is led to inquire whether they could have resulted simply from running water." Dr. Hitchcock shrewdly adds, a few lines later, "There is another agency which I have often suspected may have been concerned, and that is ice." But the discussion shows that true notions of the conjoint action of water and ice were not, as indeed they could not then be, in the author's thought. And it must be confessed that the study of existing glaciers has yet to proceed considerably, before we can have a clear and satisfying mental picture of the formation of kames.

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* Vanuxem, Geol. 3rd Dist., pp. 218–219.

† Vol. II, pp. 366–370.

The kames afford a further illustration of our main theme. It is sometimes held that they yet preserve their precise constructional form, and that the recency of the ice invasion is proven by their unbroken, flowing contours. That they are not often channelled by erosion is true. But this may be due to want of gathering surface for streams upon their small summits. On general principles one would expect a notable softening of outlines by creep and rain wash, even if these mounds date no farther back than eight or ten thousand years. Illustrations from regions of active glaciation, notably one of Professor I. C. Russell's photographs of morainic kame from the Malaspina glacier, add force to the suggestion. Thus the kame is a very complex product of water acting under glacial conditions, and of subsequent moulding influences.

The same kind of illustration is afforded by the esker, a rectilinear, or curvilinear ridge of discordantly stratified material, being in structure like the kame, but having a topography of its own ; also by the fossil delta, or sand plain, described by Davis and others, and dependent upon a group of topographic and other conditions accompanying the retirement of the ice.

Even the moraine, so often thought to be a simple mass of bowlders or bowlder clay, and solely the work of ice, is as good a type as any of composite genesis. Both the constitution and the surface expression of moraines depend on the local lithology and topography, and morainic accumulation must often be said to consist, for the major part, of washed and stratified material. A shoved moraine of true till may be worked over and deposited as kame or esker, without losing all of its finer constituents, and without complete obliteration of the glacial gravings upon its pebbles. On the other hand, a mass of kames may be pushed up into a true shoved moraine, losing its structure, but retaining the coarseness and water-worn character of its fragments. Many of the gravel beaches of the New England coast are fed from drumlins or other masses of till, giving us shore deposits of glacio-marine origin.

Glaciation as a whole is a vastly important geographic agent, and its results are curiously interwoven with conditions of pre-existing topography and post-glacial activity. The same principle is strongly suggested in the causal field of glacial geology. Few geologists would, I suppose, give in their adhesion to a purely astronomic cause, and equally few would care to deny that celestial changes may have had some efficiency. If, on the other hand, a majority incline to geographic causes, the field for complex action is narrowed, but hardly simplified. We may indeed, with some freedom, assert the complexity and consequent difficulty of all great world-shaping forces. It is the same whether we study glaciers, volcanoes, earthquakes,* or the continents.†

The co-operation of other agencies with streams in valley making is an important illustration of the general principle with which we are dealing. In the earlier days of geology, when valleys were attributed to every agent but the streams which were at work in them, it was natural that the advocates of the new doctrine should exaggerate the efficiency of the stream. This inadequate view has not, at least until recent years, been suitably qualified by attention to other agencies, such as are covered by the broad term weathering.‡ The best illustrations of this truth are found in the talus slopes, bordering the base of cliffs, awaiting the river's first service, not abrasion, but transportation; and further, in the fact that river valleys are often narrow in hard rocks and wide in soft rocks, as is true of the Hudson of the Highlands compared with the Hudson of the Catskill region.§

The structures, to which we may apply in its broadest sense the term terrace, afford a good illustration of our principle, whether we note the variety of causes which may introduce horizontal elements into the landscape, or consider the network of agencies to which a single sort of these structures is often due. Thus we may have the terraces described by Chamberlin as morainic,‖ formed on the flanks of ice tongues, graduating at one end into the moraine, and becoming a smooth bench at the other. Other benches are due to glacial fluting and appear as rock shelves more or less mantled with unconsolidated material. They range in all degrees of variation, from approximately horizontal to the typical drumlinoid curve, and when of the former sort may closely simulate benches of diverse origin.

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* See Report on the Charleston Earthquake, C. E. Dutton, 9th An. Rep. U. S. Geol. Surv., p. 211.

† Continental Problems, Presidential Address by G. K. Gilbert, see Bull. Geol. Soc. of America, Vol. 4, pp. 179–190.

‡ See "The Geological Dates of Origin of Certain Topographic Forms on the Atlantic Slope of the United States," Bull. Geol. Soc. of America, Vol. 2, p. 579; also a passage by the writer, "Rivers and the Evolution of Geographic Forms," Bull. Am. Geog. Soc., Mar., 1892, pp. 6–8.

§ W. M. Davis, Bull. Geol. Soc. of America, Vol. 2, pp. 570–571.

‖ Term. Mor. Sec. Gl. Ep., 3rd An. Rep. U. S. Geol. Surv., p. 304.

We have also to note again in this connection the differential weathering of undisturbed sedimentary beds of varying hardness, giving rise to rock platforms and associated escarpments of varying height, according to the thickness of the beds or the frequency of their alternation. Geikie describes comparable structures etched from lava beds of "variable destructibility" in the Isle of Eigg * and in Skye. These are further illustrations of the importance of general weathering in the genesis of our geography. It is probable that many benches are a composite of differential weathering and glacial fluting, the character of the platform depending on the relative importance of the two, and upon the more general features of the pre-glacial topography. If weathering were extensive and glacial action moderate, we should probably find broad benches, approximating the horizontal attitude. If glacial action were in excess, the resemblance to the terrace would be lost in the approach to the drumlin contour.

Marine and lacustrine action give origin to other horizontal platforms. If these are in close association with the ocean, they are readily referred to their cause. If, however, they are far inland and do not afford marine fossils, their interpretation is less simple. Thus, Professor Spencer holds as marine many high level beaches about the Laurentian basin which the majority of observers connect with glacial lakes. In all cases of lacustrine and marine platforms the type varies with the topography, the character of the materials carved out and transported, and the direction of prevailing winds as compared with the trend of the shore lines. According to situation, we shall have "wave-cut," or destructive beaches, or wave-built,—constructive beaches. In the case of inland beaches suspected to be of marine origin, the detrital platform may be either truly marine, or estuarine, the decision resting both upon topographic relations and upon the nature of the fossils. In the case of the lake, the beaches may have been more or less isolated from bodies of water by desiccation, as in the case of Lake Bonneville; by retirement of ice barriers, as most hold regarding Lake Agassiz and Lake Iroquois; or by sedimentation and drainage, as is true of vast numbers of the smaller extinct lakes.†

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* Scenery of Scotland, pp. 217–218.

† For a full discussion of Lake Beaches, see Topography of Lake Shores, G. K. Gilbert, 5th An. Rep. U. S. Geol. Surv., pp. 69–123; or, Lake Bonneville, Monograph I, U. S. Geol. Surv., pp. 23–89.

If we turn to river terraces, the complication of causes and resulting structures is quite as noteworthy. At the outset we have to note two classes, in which results differ according to the material in which a river works. If it be the bed-rock of a region, we have "terraces of planation."* If terraces be carved from loose valley filling, they are then called alluvial terraces. The paper to which reference has just been made, suggests some facts pertinent to our discussion. Thus the writer, alluding to phases of river work in successive geographical cycles, says (p. 258): "Involved terraces, or, as it seems better to call them, complex terraces, are due to a combination of causes acting jointly or in succession, and continuing through the whole or part of one or more geographical cycles. If we could know all the factors that have determined the formation of most of the terraces we see at the present day, I think that we should find them to be better classed as complex terraces than under any other heading in the classification thus far proposed." Upward and downward oscillations controlling the gradient of streams, nearness or remoteness of divides, character of adjacent river basins, changes of climate, involving glaciation or variation in rain-fall, the relation of a river to its tributaries, and the character of the rock-beds upon which it does its work, are all factors of importance in making a given terrace what it is.

A further illustration of complex origin is afforded by lake basins. In a former bulletin of this Society, the writer has discussed the composite genesis of the Finger Lake basins of New York.† The view is taken that the depressions were initiated by preglacial river work, which of itself is a highly composite factor. A portion of the valleys was deepened, within limits largely determined by the character of the local terranes, by glacial action. Dams of greater or less height were then created by fillings of ground moraine, the basins were deepened by recovery from northward continental depression, and the final touches were put upon them by sedimentation, wave erosion of shore cliffs and a small down-cutting of their outlets.

The strenuous holding of opposite views of the making of the Great Lakes affords a presumption, at least, of their composite origin. And it would be rash to deny that river erosion, general weathering, glacial scooping and blockade, warping of the crust, and differences between the various Paleozoic and pre-Paleozoic terranes have all had some important share in the great result. The elaborate nature of the Great Lake problem has been well set forth in a paper by Professor I. C. Russell.* The paper is not intended to embody a theory, but to state the conditions of the problem. I quote a single passage (p. 398) as in point here: "As the case stands at present it appears that there is evidence of a pre-glacial valley or series of valleys as has been claimed by several geologists, and that all but the boldest features of the old topography have been obliterated or greatly modified by glacial erosion followed by glacial and other sedimentation. Additional observations should show somewhat definitely the amount of work assignable to particular portions of the history. How far the results of subaërial and of glacial erosion have been modified by other agencies, more especially by orographic movements, has also to be considered." The late Dr. J. S. Newberry represents the extreme advocacy of the glacial origin of these great features of American geography, while Professor Spencer denies for the most part the efficiency of ice, holding to river erosion, sea invasion and crust movements. We may expect that these and other agents and conditions will be well averaged when the verdict is made up.

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* See Geographical Development of Alluvial River Terraces, by Richard E. Dodge, Proc. Boston Soc. Nat. Hist., Vol. XXVI, p. 258.

† Bull. Am. Geog. Soc., Vol. XXV, No. 2, 1893.

We take, in further illustration of composite origin, the coöperation of agents in certain extensions of continental borders and in developing insular masses. Le Conte's account of the growth of Southern Florida is a good case.† He notes first the formation of a sub-marine bank by the Gulf Stream. Corals then gain a foothold and add their hard framework and more or less comminuted debris to the pile. The coral and other material is then brought by wave action into the aërial zone. A certain amount of land rubbish is also transported from the materials of ordinary erosion on the continent and adjacent islands. The work is completed by the extension of the water-loving mangrove trees and the entanglement of land wash and organisms among their roots.

The Bermuda Islands afford a kindred case. Upon a substructure of some sort is built a cluster of islands whose visible rocks are exclusively limestone. The steps in the constructive process are: growth of organisms, especially corals; comminution and redistribution by the waves; eolian action upon beach sand raising the beds to a maximum height of a little more than 200 feet; the percolation of rain and sea water and consequent solution, cavern making, re-deposition and cementation; weathering and shore abrasion, giving rise to notable sea caves and lofty escarpments. So complicated are the forces which continually shape this island mass, although lithologically it is perfectly homogeneous.

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* Geological History of the Laurentian Basin, in series of "Studies for Students," Jour. Geol., Vol. I, May–June, 1893, pp. 394–410.

† Elements of Geology, p. 160.

Our principle is likewise well seen in the formation of atolls and barrier reefs. If we take Darwin's theory, we have the formation of the support of the coral mass chiefly by vulcanism, the growth of corals with wave and wind action as before, and continued subsidence, as the chief factors. If we take Murray's theory, we have, if possible, a longer list of conspiring causes. The submarine foundation may be one of accidental volcanic elevation to the required height, or a cone truncated by the waves, or a more deeply buried, primitive platform built up by the remains of pelagic organisms. Coral growth, wave and wind action, occur as usual, but with non-growth, and solution at the centre, in room of subsidence, to account for the lagoon. If, as held by some, both theories are true, each holding in certain cases, we find a still more complicated network of agencies, and a still better illustration of our principle.

The formation of coast islands is dependent upon several conditions. They may be constructive, built up as low, off-shore islands, where waves break and drop their load on a slowly descending marginal sea bottom. If wind and consequent wave action are powerful, tracts of the mainland may be insulated by the cutting away of surrounding areas. This is especially true of hard coast rocks bordered by those which are more yielding to mechanical agencies. If the land be undergoing a downward movement, headlands and any eminences adjoining the shore may be surrounded by the transgression of the waves. Insulation by surrounding erosion and by subsidence are likely to proceed together and to have joint efficiency in the production of the island form.

There can be no question of the importance of the considerations here set forth to the geographic investigator. This is true of students who set themselves to an exhaustive review of limited and familiar areas, and is no less true of explorers in fresh or remote fields. We cannot measure the degree to which reports of official explorations and private travel would have been enriched, during even the more recent decades, had the writers been, more often than they were, observers in this true and high sense.

Even more, if possible, may be said of the usefulness of such doctrines in geographic teaching. A recent pedagogical document contains a reference to the land, the water and the air, as the "three dead geographic forms." The writer indeed used the expression in contrast with the biologic groups, but even thus it seems to me peculiarly unhappy and inappropriate, in view of that composite moulding, delicate balance and sensitiveness to change, which characterizes the forms with which geography deals. There can be no more profitable use, or effective stimulus, of the imaginative powers of a youth than the effort to realize vividly the growth of a geographic individual. More and more is this true as the student advances from one form to another, and finally becomes able to combine in panoramic review the elements of the complicated and progressive history of a region.* The teacher of Physiography has no greater reward than is his when a student assures him that henceforth his native State will be to him a new country, or that he shall see the hills and valleys of his old home with new eyes. This is precisely because he has learned to interpret the forms in the light of their origin, to read the work of the frost, the rain and the plant, to measure the achievement of the river, with perception of its past and prophecy of its future, or to see where the glacier has traced its unmistakable inscription. Every journey becomes fraught with meaning, and the traveller who has caught the spirit of modern geography will not report the great plains of Kansas and Nebraska as "uninteresting." It must, however, still be said that many colleges deny their graduates this appreciative eye. But even the secondary and earlier grades cannot much longer deprive their pupils of this best fruit of geographic study.

COLGATE UNIVERSITY,
January, 1895.

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* For the fullest expositions of geographic development in its pedagogic significance see several papers by Professor W. M. Davis, Geographical Illustrations or Suggestions for Teaching Physical Geography, Based on the Physical Features of Southern New England, Pub. by Harv. Univ.; The Improvement of Geographical Teaching, Nat. Geog. Mag., Vol. V, pp. 68–75; Physical Geography in the University, Jour. Geol., Vol. II, Jan.–Feb., 1894, pp. 66–100. Teachers may also consult with profit, Report of Conference on the Teaching of Geography, accompanying the Report of the Committee of Ten on Secondary School Studies, pub. by the U. S. Bureau of Education.